800829

ENVIRONMENTAL LEVELS OF RADIOACTIVITY FOR THE OAK RIDGE AREA

(Report for Period, July - December, 1964)

Compiled by the

Applied Health Physics Section

Health Physics Division

OAK RIDGE NATIONAL LABORATORY

#501

Introduction

Radioactive waste materials arising from the operation of atomic energy installations at Oak Ridge are collected, treated, and disposed of according to their physical states.

Solid wastes are buried in a Conasauga shale formation. This shale has a marked ability to fix radioactive materials by an ion exchange mechanism.

Liquid wastes which contain long-lived fission products are confined in storage tanks or are released to trenches located in the Conasauga shale formation. Low level liquid wastes are discharged, after preliminary treatment, to the surface streams.

Air that may become contaminated by radioactive materials is exhausted to the atmosphere from several tall stacks after treatment by means of filters, scrubbers, and/or precipitators.

This report presents data on the environmental levels of radioactivity for the Oak Ridge Area and compares the data with established maximum permissible concentrations.

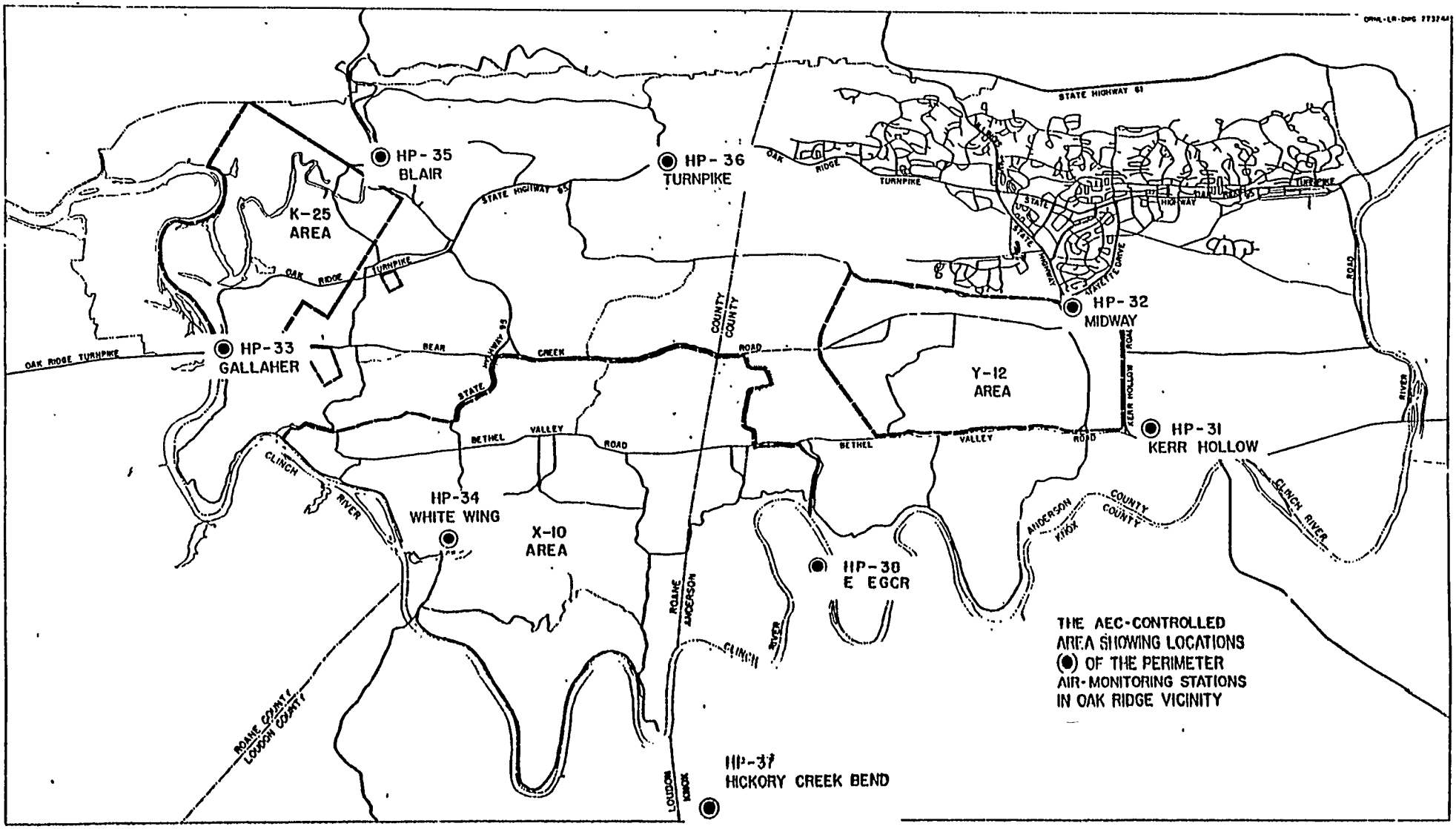
Air Monitoring

Atmospheric contamination by long-lived fission products and by fallout occurring in the general environment of East Tennessee is monitored by two systems of monitoring stations. One system consists of eight stations which encircle the plant area (Fig. 1) and provide data for evaluating the impact of all Oak Ridge Operations on the immediate environment. A second system consists of seven stations encircling the Oak Ridge Area at distances of from 12 to 75 miles (Fig. 2). This system provides data to aid in evaluating local conditions and to assist in determining the spread or dispersal of contamination should a major incident occur. Sampling for radioactive particulates is carried out by passing air continuously through a filter paper. Airborne radioactive iodine is monitored in the immediate environment of the plant areas by passing air through a cartridge containing activated charcoal. Data collected are accumulated and tabulated in average μc/cc of air sampled.

Atmospheric contamination by alpha-emitting materials, interpreted as uranium, is determined by taking continuous air samples at three locations on a five-mile radius from the Oak Ridge Gaseous Diffusion Plant (Fig. 3).

Milk Monitoring

Raw milk is monitored for ^{131}I and ^{90}Sr by the collection and analysis of samples from twelve sampling stations located within a radius of 50 miles of ORNL. Samples are collected weekly at each of eight stations



STATION SITES FOR PERIMETER AIR MONITORING SYSTEM

Figure 1

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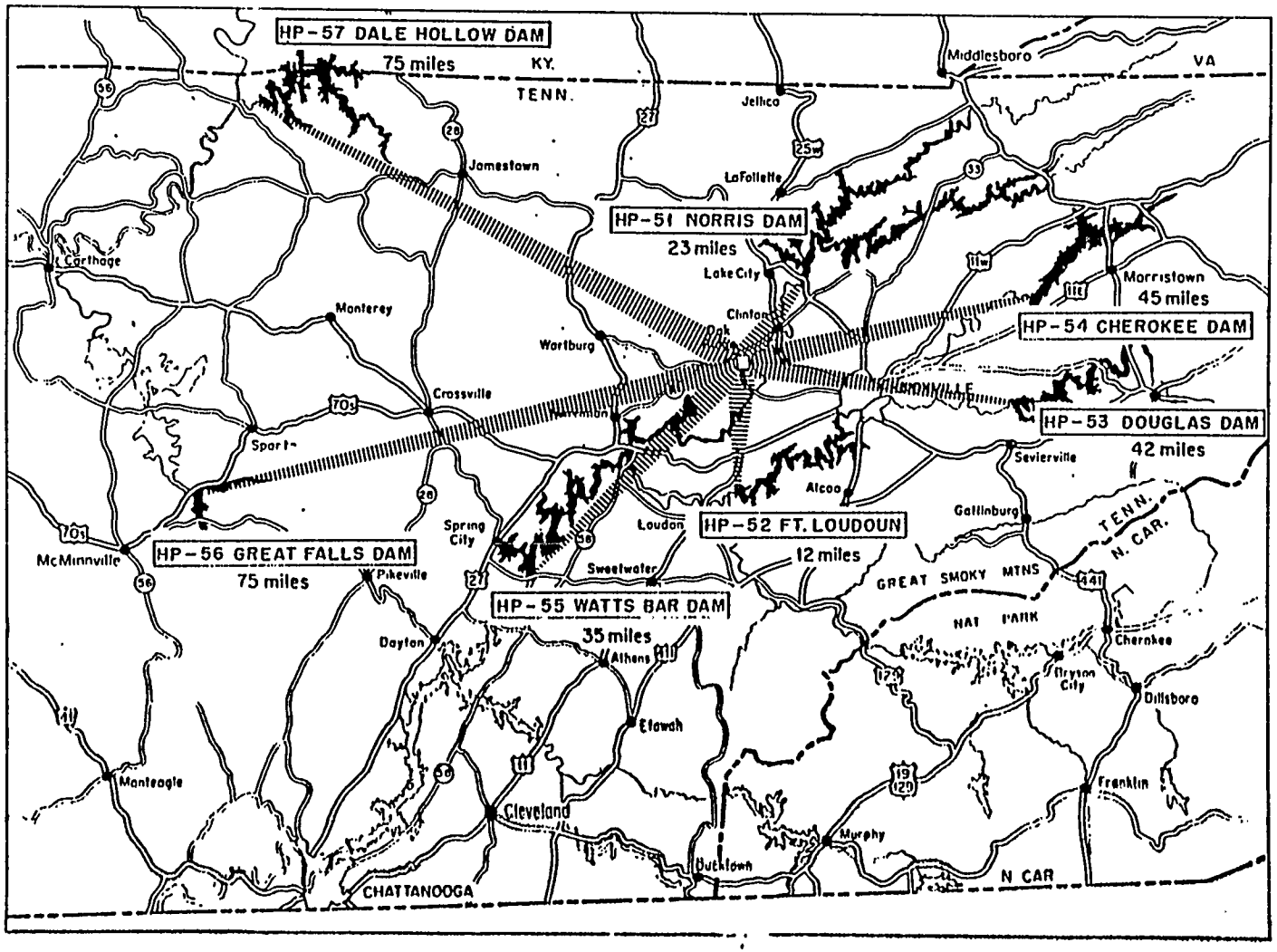
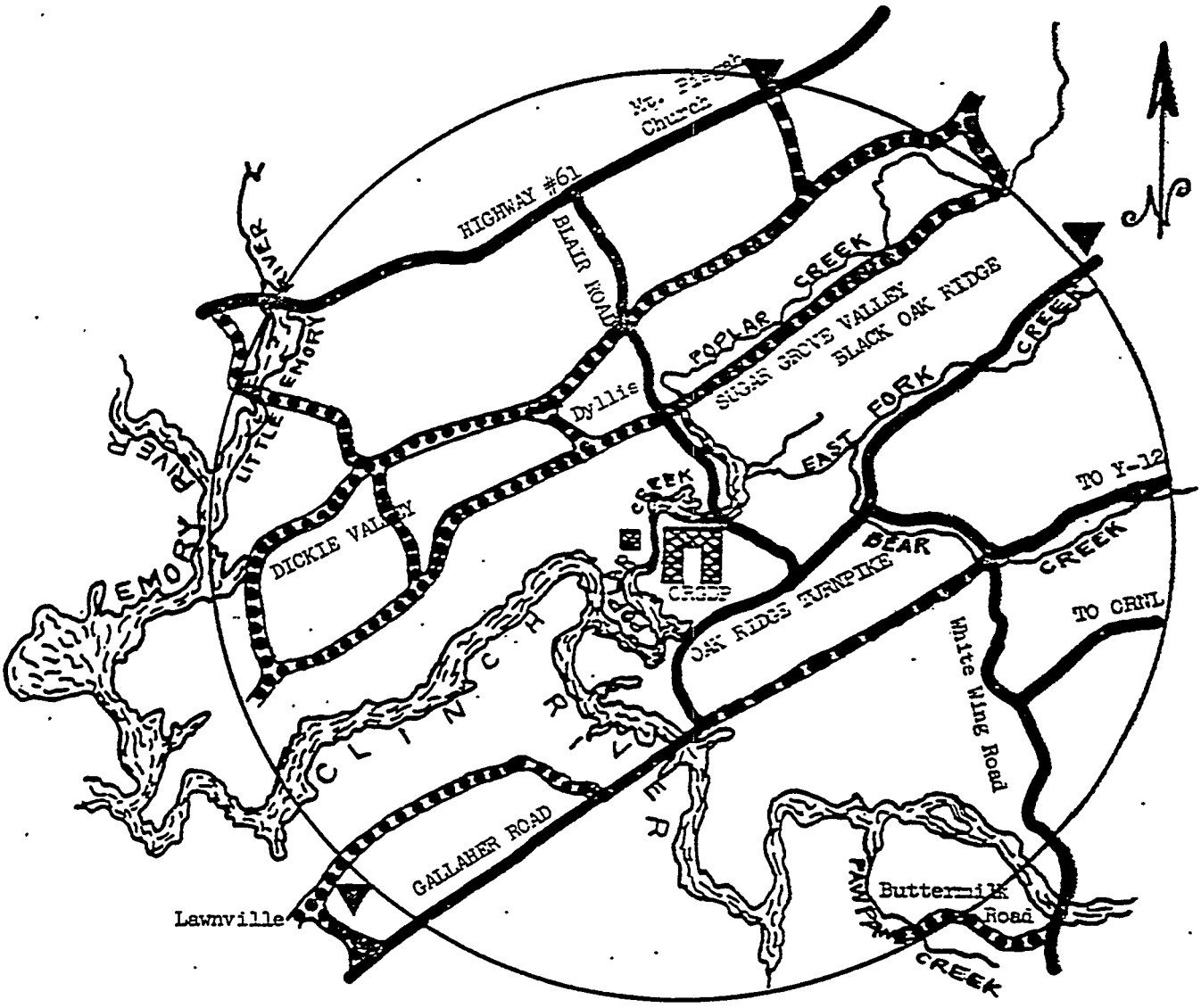


STATION SITES FOR REMOTE AIR MONITORING SYSTEM

Figure 2



SAMPLING POINTS OF OUTSIDE ENVIRONS -- ORGDP

AIR

▼ Sampling Location - Five Miles from Plant

Figure 3

located on the fringe of the Oak Ridge Area. Four stations, located more remotely with respect to Oak Ridge Operations, are sampled at a rate of one station each week. The purpose of the milk sampling program is two-fold: first, samples collected in the immediate vicinity of the Oak Ridge Area provide data by which one may evaluate possible exposure to the neighboring population resulting from waste releases from Oak Ridge Operations; second, samples collected at the more remote stations provide background data which are essential in establishing the proper index for the evaluation of data obtained from local samples.

Water Monitoring

Large volume, low level liquid wastes originating at Oak Ridge National Laboratory are discharged, after some preliminary treatment, into the Tennessee River system by way of White Oak Creek and the Clinch River. Liquid wastes originating at the Oak Ridge Gaseous Diffusion Plant and the Y-12 Plant are discharged to Poplar Creek and thence to the Clinch River. Releases are controlled so that resulting average concentrations in the Clinch River comply with the maximum permissible levels for populations in the neighborhood of a controlled area as specified by AEC Manual, Chapter 0524. The concentration of radioactivity leaving White Oak Creek is measured and concentration values for the Clinch River are calculated on the basis of the dilution provided by the river.

Radioactive liquid wastes are sampled at a number of locations as shown in Figs. 4 and 5. Samples are taken at a number of locations in the Clinch River, beginning at a point above the entry of wastes into the river and ending at Center's Ferry near Kingston, Tennessee. Stream gauging operations are carried on continuously to obtain dilution factors for calculating the probable concentrations of wastes in the river.

Samples are analyzed for the long-lived beta emitters, for uranium, and for the transuranic alpha emitters.

Analyses are made of the effluent for the long-lived radionuclides only, since cooling time and hold-up time in the waste effluent system is such that short-lived radionuclides are normally not present. The concentrations of those isotopes present in significant amounts are determined by analysis. A weighted average maximum permissible concentration for water, $(MPC)_w$, for the mixture of radionuclides is calculated on the basis of the isotopic distribution using the MPC values of each isotope as specified by AEC Manual, Chapter 0524.[1] The average concentrations of gross beta activity in the Clinch River are compared to the calculated $(MPC)_w$ values.

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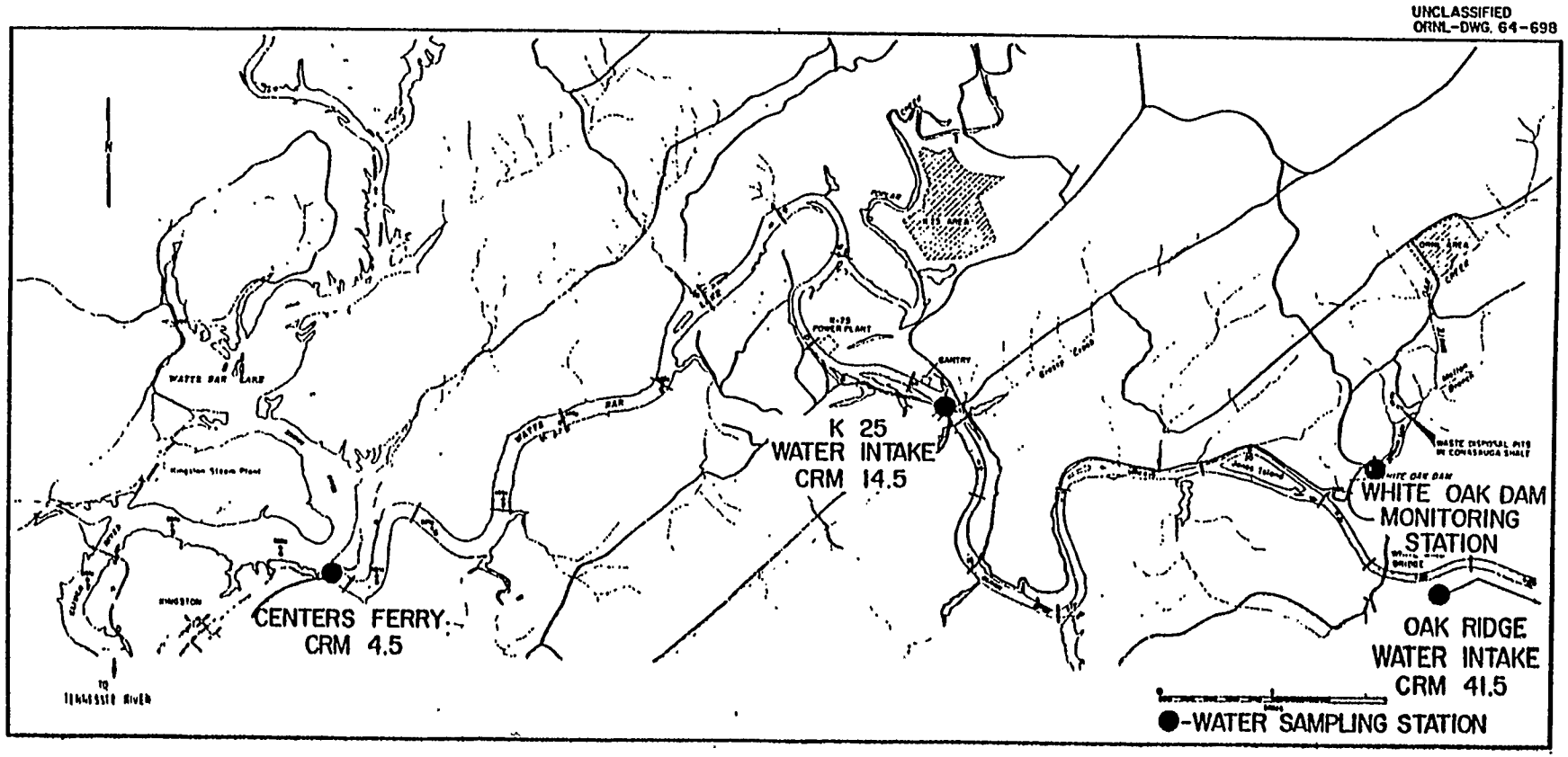
[1]AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.



WATER SAMPLING LOCATIONS

Figure 4

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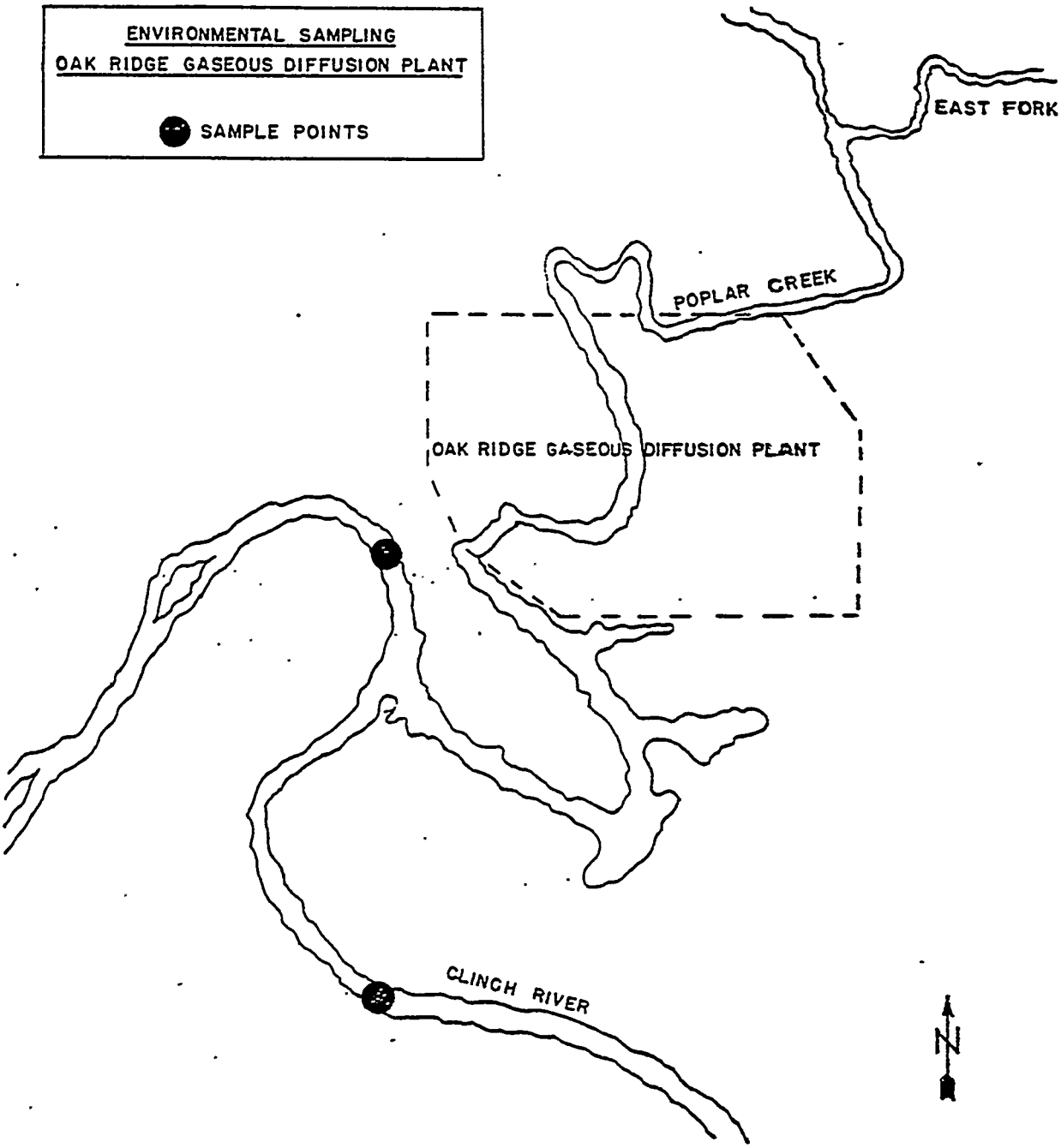

Figure 5

The concentration of uranium is compared with the specific $(MPC)_w$ value for uranium.

Gamma Measurements

External gamma radiation levels are measured monthly at a number of locations in the Oak Ridge Area. Measurements are taken with a Geiger-Müller tube at a distance of three feet above the ground, and the results are tabulated in terms of mR/hr.

Discussion of Data

Data on the environmental levels of radioactivity for the last half of 1964 in the Oak Ridge and surrounding areas are presented in Table I through Table IX.

The average air contamination levels for gross beta activity, as shown by the continuous air monitoring filter data for the immediate and remote environs of the plants, were 0.39% and 0.46%, respectively, of the maximum permissible concentration for populations in the neighborhood of a controlled area. These values are approximately 70% lower than those of the first half of 1964 and are no higher than the average of those measured in other areas of the United States and reported by the U.S. Public Health Service Radiation Surveillance Network for the period July through October, 1964.

The average concentration of ^{131}I in air in the immediate environs of the plants was 0.018×10^{-12} µc/cc (Table II). This is approximately 0.018% of the maximum permissible concentration for populations in the neighborhood of a controlled area.

The average airborne alpha activity in the environs of the ORGDP, five miles from ORGDP, was 7.5% of the maximum permissible concentration for populations in the neighborhood of a controlled area.

The average concentration of ^{131}I in raw milk in the immediate and remote environs of the Oak Ridge Area were 7.0 pc/l and 5.4 pc/l, respectively. These values fall within the limits of FRC Range I if one assumes the average intake per individual to be 1 liter of milk per day. The maximum concentration observed in any one milk sample was 72 pc/l. This was observed in the immediate environs of the controlled area and was associated with the release of approximately 1200 millicuries of ^{131}I from the plant stacks during a period of one week.

The average concentrations of ^{90}Sr in raw milk collected in the immediate and remote environs of the controlled area were 20 pc/l and 19 pc/l, respectively. These values approach the lower limit of FRC Range II for transient rates of daily intake of ^{90}Sr for application to the average of suitable samples of an exposed population.

The calculated average concentration of radioactivity in the Clinch River at Mile 20.8, the point of entry of most of the wastes, and the measured average concentration at Mile 4.5, near Kingston, Tennessee, were 3.1×10^{-8} μc/ml and 2.0×10^{-8} μc/ml, respectively. These values are 0.65% and 0.80% of the weighted average maximum permissible concentrations $(MPC)_w$. The average concentration of transuranic alpha emitters in the Clinch River at Mile 20.8 was 0.86×10^{-11} μc/ml which is < 0.001% of the weighted average $(MPC)_w$ value.

The average activity of natural uranium materials in the Clinch River, reflecting the effects of all Oak Ridge plants, was < 0.01% of the $(MPC)_w$ for uranium.

The average external gamma radiation measured in the town of Oak Ridge and at the perimeter of the Oak Ridge Area averaged 0.013 mR/hr.

Conclusion

Comprehensive surveillance of the radioactivity in the Oak Ridge environs indicated that a large part of the radioactivity detected continues to be the result of fall-out from previous weapons testing. While some low level radioactivity is being released to the environment in the form of gaseous and liquid wastes from plant operations, the resulting concentrations in both the atmosphere and surface streams of the Oak Ridge environment are well below established maximum permissible concentrations and daily intake guides for the neighboring population.

TABLE I

CONTINUOUS AIR MONITORING DATA

Long-Lived Gross Beta Activity of Particulates in Air

July - December, 1964

Station Number	Location	Number of Samples Taken	Units of 10^{-13} µc/cc			% $(MPC)_a$[c]
			Maximum[a]	Minimum[b]	Average	
		Perimeter Stations				
HP-31	Kerr Hollow Gate	26	9.9	1.4	3.6	0.36
HP-32	Midway Gate	26	18	0.96	5.3	0.53
HP-33	Gallaher Gate	26	9.7	0.48	3.1	0.31
HP-34	White Oak Dam	26	8.7	1.3	3.5	0.35
HP-35	Blair Gate	26	14	1.2	4.2	0.42
HP-36	Turnpike Gate	186[d]	13	1.1	4.3	0.43
HP-37	Hickory Creek Bend	26	11	1.2	3.7	0.37
HP-38	East of EGCR	23	12	1.5	3.5	0.35
Average			12	1.1	3.9	0.39
		Remote Stations				
HP-51	Norris Dam	26	15	1.4	4.5	0.45
HP-52	Loudoun Dam	25	16	0.41	4.7	0.47
HP-53	Douglas Dam	26	18	1.3	5.0	0.50
HP-54	Cherokee Dam	26	17	0.76	5.3	0.53
HP-55	Watts Bar Dam	26	16	1.1	4.5	0.45
HP-56	Great Falls Dam	26	11	0.61	3.8	0.38
HP-57	Dale Hollow Dam	26	13	0.85	4.1	0.41
Average			15	0.92	4.6	0.46

[a] Maximum weekly average concentration.

[b] Minimum weekly average concentration.

[c] $(MPC)_a$ is taken to be 10^{-10} µc/cc as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

[d] Samples collected on daily schedule beginning 5/7/62. Maximum and minimum daily average concentrations were 22 x 10^{-13} µc/cc and 0.3 x 10^{-13} µc/cc, respectively.

TABLE II

CONCENTRATION OF ^{131}I IN AIR
AS MEASURED BY THE PERIMETER AIR MONITORING STATIONS

July - December, 1964

Number of Samples	Units of 10^{-12} µc/cc			% $(MPC)_a$ [b]
	Maximum	Minimum[a]	Average	
208	0.32	< 0.010	0.018	0.018

[a] Minimum detectable amount of ^{131}I is 20 d/m. At the average sampling rate used, this corresponds to approximately 0.010 x 10^{-12} µc/cc. In averaging, one-half of this value, 10 d/m, is used for all samples showing a total amount of ^{131}I less than 20 d/m.

[b] $(MPC)_a$ is taken to be 1 x 10^{-10} µc/cc as specified in AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

TABLE III

OAK RIDGE GASEOUS DIFFUSION PLANT AIR MONITORING DATA

July - December, 1964

Distance from Center of Plant	Type of Analyses	No. of Samples*		Units of 10^{-13} µc/cc					Avg. % $(MPC)_a$**
				Directon from Plant			Avg.	$(MPC)_a$	
				North	North East	South West			
5 Mile Radius	Gross Alpha	1532	Max.	7	8	11			
			Min.	< 1	< 1	< 1			
			Avg.	1.5	1.6	1.5	1.5	20.0	7.5

* Normal Sampling Frequency: Continuous, averaged over 8 hours.

** Maximum permissible concentration for continuous exposure of the general public.

TABLE IV

CONCENTRATION OF ^{131}I IN RAW MILK

July - December, 1964

Location	pc/l		
	Maximum	Minimum*	Average
Immediate Environs	72	< 10	7.0
Remote Environs	12	< 10	5.4

*Minimum detectable concentration of ^{131}I is 10 pc/l. In averaging, one-half of this value, 5 pc/l, was used for all samples showing a concentration less than 10 pc/l.

TABLE V

CONCENTRATION OF ^{90}Sr IN RAW MILK

July - December, 1964

Location	pc/l		
	Maximum	Minimum*	Average
Immediate Environs	78	< 2.0	20
Remote Environs	58	< 2.0	19

*Minimum detectable concentration of ^{90}Sr in milk is 2 pc/l. In averaging, one-half of this value, 1 pc/l, was used for all samples showing a concentration less than 2 pc/l.

TABLE VI

CALCULATED AVERAGE CONCENTRATION OF RADIOACTIVITY
IN THE CLINCH RIVER AT MILE 20.8

July - December, 1964

Number of Samples Taken	Units of 10^{-7} µc/ml			% of $(MPC)_w$
	Maximum[a]	Minimum[b]	Average	
183	2.3	0.10	0.31	0.65

[a]Maximum weekly average.

[b]Minimum weekly average.

TABLE VII

AVERAGE CONCENTRATION OF MAJOR RADIOACTIVE CONSTITUENTS
IN THE CLINCH RIVER

July - December, 1964

Location	Units of 10^{-8} µc/ml								% of $(MPC)_w$
	^{90}Sr	^{144}Ce	^{137}Cs	^{106}Ru	^{60}Co	^{95}Zr - ^{95}Nb	Average Beta Activity	$(MPC)_w$[a]	
Mi. 41.5[b]	0.09	0.04	0.02	0.20	*	*	0.35	100	0.34
Mi. 20.8[c]	0.09	<0.01	0.04	1.7	0.21	<0.01	3.1	480	0.65
Mi. 4.5	0.19	0.06	0.25	1.3	0.21	*	2.0	250	0.80

[a]Weighted average $(MPC)_w$ calculated for the mixture using $(MPC)_w$ values for specific radionuclides specified by AEC Manual, Chapter 0524, Appendix, Annex 1, Table II.

[b]Sampling station moved from Clinch River Mile 33.8 to Mile 41.5 about January 1, 1962.

[c]Values given for this location are calculated values based on levels of waste released and the dilution afforded by the river; they do not include amounts of radioactive material (e.g., fall-out) that may enter the river upstream from CRM 20.8.

*None detected.

TABLE VIII

URANIUM CONCENTRATION IN THE CLINCH RIVER

July - December, 1964

Sampling Point	Type of Analyses Made	No. of Samples*	Units of 10^{-8} µc/ml				% $(MPC)_w$
			Maximum	Minimum	Average	$(MPC)_w$	
Upstream from ORGDP	Uranium Concentration	4	0.2	0	0.1	2000	< 0.01
Downstream from ORGDP	Uranium Concentration	4	0.1	0	0.1	2000	< 0.01

*Normal Sampling Frequency: Continuous, composited over one week.

TABLE IX

EXTERNAL GAMMA RADIATION LEVELS

mR/hr

July - December, 1964

Station Number	Location	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1	Solway Gate	0.018	0.014	0.014	0.014	0.013	0.011	0.014
2	Y-12 East Portal	0.011	0.011	0.010	0.012	0.011	0.014	0.012
3	Newcomb Road, Oak Ridge	0.013	0.013	0.013	0.013	0.012	0.011	0.013
4	Gallaher Gate	0.015	0.015	0.013	0.014	0.017	0.015	0.015
5	White Wing Gate	0.014	0.018	0.011	0.012	0.013	0.014	0.014
Average		0.014	0.014	0.012	0.013	0.013	0.013	0.013

Note: These readings were taken with a calibrated Geiger-Müller tube at a distance of three feet above the ground.

The background in the Oak Ridge area in 1943 was determined to be approximately 0.012 mR/hr.

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